Bio-calcification and its response to ocean acidification: new insights from boron isotopes

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Bio-calcification is not only responsible for building the majestic coral reefs of the tropics, but is also a determinant of the oceans carbonate chemistry and ultimately the CO_2 content of the biosphere upon which life depends. By its very nature, biomineralisation occurs within a restricted, physiologically controlled environment, whose connectivity to external seawater is poorly known. Understanding these factors is thus fundamental to quantifying the response of this key group of organisms to CO_2 driven climate change and ocean acidification. Boron isotopes are an ideal tool to interrogate these processes, as its speciation is pH dependent, and biocalcifiers specifically incorporate the isotopically distinct borate species into their carbonate skeleton.

Using boron isotope systematics we show how biological up-regulation of the pH of the calcifying fluid is a characteristic of both azooxanthellate and zooxanthellate aragonitic corals. Scleractinian corals up-regulate pH at their site of calcification such that internal changes are approximately one-half of those in ambient seawater [1]. Although the absolute magnitude of the pH-buffering capacity is species-dependent, it provides a mechanism to raise the saturation state of the calcifying medium, thereby potentially increasing calcification rates at relatively little additional energy cost. This is especially evident in deep-sea corals where high degrees of pH up-regulation has facilitated calcification at, or in some cases below, the aragonite saturation horizon. Models [2] combining biologically induced pH regulation with abiotic calcification, (IpHRAC) now make it possible to unravel the effects of increased temperature and reduced seawater saturation states on bio-calcification. Up-regulation of pH is not however ubiquitous among all calcifying organisms; those lacking this ability may undergo severe declines in calcification as CO_2 increases.

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Continuous measurement of methane emissions from a landfill using a new laser-based open path instrument

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A new laser-based open path methane analyzer (LI-7700, LI-COR Biosciences) was used to measure methane emission rates by eddy covariance from June to December 2010 at the municipal landfill in Lincoln, NE USA. The instrument provides continuous measurements at 10 Hz with minimal maintenance and can operate on solar power. High frequency corrections for effects of temperature and water vapor on methane absorption spectra, and operation in dusty environments present special challenges that will be discussed. Methane concentrations varied sharply from near background to more than 60 ppm. Methane emission rates varied as much as 35-fold from day to day and depended strongly on changes in barometric pressure (P), increasing with falling P and decreasing with increasing P. Emission rates were systematically higher in December than during the summer period. Higher rates were associated with changes in P that were larger in magnitude and longer in duration in winter than in summer, and with lower mean temperatures, which appeared to reduce methane oxidation rates. Power spectrum and ogive analysis showed that 10 days of averaging were required to capture 90% of the variance in emission rate. Implications of these results for estimating landfill emission rates will be discussed.

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